

WAR DEPARTMENT

TECHNICAL MANUAL

RECORDER BC-1016

May 6, 1943

**WAR DEPARTMENT**

Washington, May 6, 1943.

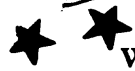
This Technical Manual, published by Waters Conley Co. on orders no. 14087-PHILA-43, 14146-PHILA-43, and 15559-PHILA-43, is furnished for the information and guidance of all concerned.

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TECHNICAL MANUAL  
No. 11-441



WAR DEPARTMENT  
Washington, May 6, 1943.

RECORDER BC-1016

Prepared under direction of the  
Chief Signal Officer

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## DESTRUCTION OF ABANDONED MATERIEL IN THE COMBAT ZONE

In case it should become necessary to prevent the capture of this equipment, and when ordered to do so, *DESTROY IT SO THAT NO PART OF IT CAN BE SALVAGED, RECOGNIZED, OR USED BY THE ENEMY. BURN ALL PAPERS AND BOOKS.*

### MEANS:—

1. Explosives, when provided.
2. Hammers, axes, sledges, or whatever heavy objects are readily available.
3. Burning by means of incendiaries such as gasoline, oil, paper, or wood.
4. Grenades and shots from available arms.

### PROCEDURE:—

1. Obliterate all identifying marks. Destroy nameplates and circuit labels.
2. Demolish all panels, castings, switch and instrument-boards.
3. Destroy all controls, switches, relays, connecting means and meters.
4. Rip out all wiring in electrical equipment. Smash water-cooling, gas and oil systems in gas-engine generators, etc.
5. Smash every electrical or mechanical part whether rotating, moving or fixed.
6. Break up all operating instruments such as keys, phones, microphones, etc.
7. Destroy all classes of carrying cases, straps, containers, etc.

### DISPOSAL:—

1. Where possible, and when time permits, bury all debris or dispose of it in streams or other bodies of water.

## SAFETY NOTICE

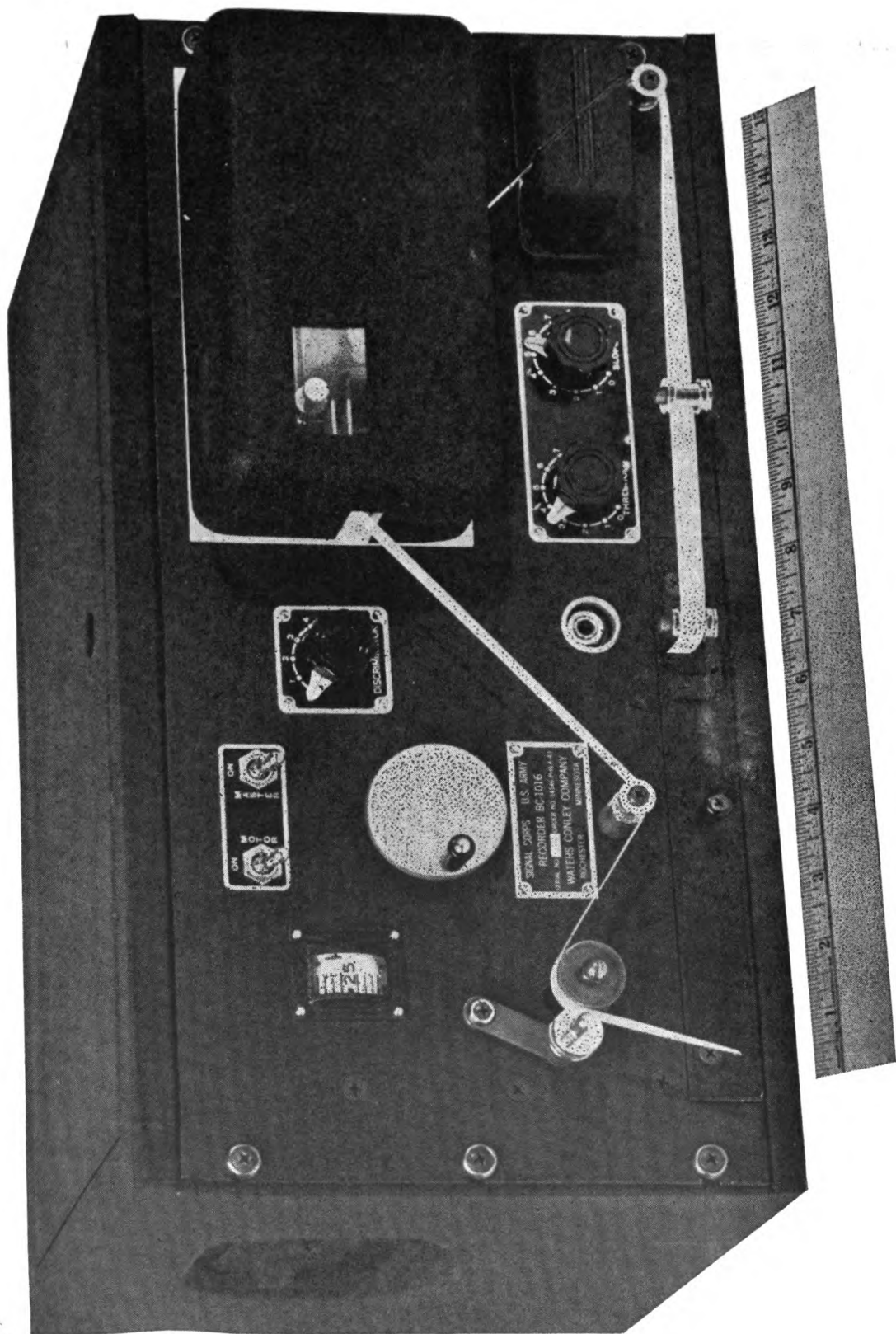
DANGEROUSLY HIGH VOLTAGES ARE AVAILABLE AT THIS EQUIPMENT. BEFORE MAKING ANY ATTEMPT TO REPAIR THIS INSTRUMENT, DISCONNECT IT FROM THE POWER SOURCE.

## CAUTION

### THINGS TO DO BEFORE CONNECTING RECORDER BC-1016 TO THE POWER LINE TO PUT IT INTO OPERATION:

1. CHECK TUBES AFTER REMOVING PACKING MATERIAL FROM INSIDE RECORDER CABINET. MAKE SURE THAT TUBES ARE IN GOOD CONDITION (VISUAL INSPECTION ONLY) AND THAT THEY FIT FIRMLY IN SOCKETS.
2. BE SURE ALL CONTROLS ARE AT O AND SWITCHES ARE AT OFF.
3. WHEN SHIPPED, A PEN IS LEFT IN THE RECORDER AND THE PEN STOP SCREWS (3131M) AND (3132M) HAVE BEEN MOVED FORWARD TO HOLD PEN IN PLACE DURING SHIPMENT. UNSCREW STOPS UNTIL THERE IS A SPACE OF ABOUT  $\frac{1}{4}$  INCH BETWEEN THEM.
4. BE SURE THAT TAPE ANVIL (3135M) IS NOT LESS THAN  $\frac{1}{4}$  INCH BELOW THE PEN POINT. TURN ADJUSTING SCREW (3140M) COUNTER-CLOCKWISE (LEFT) TO LOWER ANVIL.
5. CHECK VOLTAGE AND FREQUENCY (CYCLES) OF POWER LINE FROM WHICH RECORDER IS TO BE OPERATED. THE RECORDER IS DESIGNED FOR OPERATION OVER A VOLTAGE RANGE OF ROUGHLY 100 TO 265 VOLTS BY MEANS OF FOUR TAPS. WHEN THE VOLTAGE OF THE POWER LINE HAS BEEN DETERMINED, SET THE A-C INPUT SWITCH (2745P) TO THE APPROPRIATE VOLTAGE AS MARKED ON THE SWITCH. THE RECORDER IS DESIGNED TO OPERATE ON 50 TO 60 CYCLES ONLY. IF THE FREQUENCY (CYCLES) IS OTHER THAN 50 TO 60, DO NOT CONNECT THE RECORDER TO THE POWER LINE, BUT BRING THIS FACT TO THE ATTENTION OF THE OFFICER IN COMMAND.

6. BE SURE THE CORRECT FUSE IS IN PLACE FOR THE VOLTAGE OF THE POWER LINE TO WHICH THE RECORDER IS TO BE CONNECTED. FOR A DETAILED EXPLANATION OF THIS POINT, SEE PAR. 7B.
7. SEE THAT A PEN OF THE PROPER WIDTH FOR THE USE TO WHICH THE RECORDER IS TO BE PUT IS IN PLACE. THE FINE LINE PEN (2036P) IS IN PLACE IN THE RECORDER WHEN ORIGINALLY SHIPPED. IF THE RECORDER IS TO BE USED FOR OTHER THAN HIGH SPEED COMMUNICATION PURPOSES, SELECT AND INSTALL THE PROPER PEN. THESE PENS WILL BE FOUND IN THE TAPE DRAWER. (SEE PAR. 7H AND FIG. 5.)
8. REMOVE AND REPLACE SEVERAL TIMES THE HINGED COVER [(3158M), FIG. 4] PROTECTING THE PEN MECHANISM UNTIL YOU ARE COMPLETELY FAMILIAR WITH HOW THIS IS DONE. THE RECORDER CAN BE OPERATED WITH THIS COVER ON OR OFF. COVER HINGE IS OF SPLIT TYPE. AFTER RELEASING CATCH (3161) AND OPENING COVER, PUSH UP TO REMOVE. THE CATCH TO HOLD COVER FIRMLY IS LOCATED AS SHOWN IN FIG. 4.



**Figure 1—Recorder BC-1016.**



## SECTION I. DESCRIPTION

1. **GENERAL.**—Recorder BC-1016 (FIG. 1) is designed for ink recording of standard code signals at speeds up to 400 words per minute on  $\frac{3}{8}$ -inch paper tape. The input of the recorder may be connected to a telephone line transmitting radio signals or directly to the output circuit of a radio receiver. The recorder is a self-contained unit requiring only connection to the power supply line and a source of signal.

2. **COMPONENTS.**

a. *Cabinet Mounting.*—Recorder BC-1016 is supplied mounted in a cabinet as illustrated in FIG. 1.

MAXIMUM OVERALL DIMENSIONS  
INCLUDING PROJECTIONS

| QUAN. | NAME OF UNIT     | Height             | Width              | Depth              | Net Weight |
|-------|------------------|--------------------|--------------------|--------------------|------------|
| 1     | Recorder BC-1016 | 10 $\frac{1}{4}$ " | 19 $\frac{1}{4}$ " | 14 $\frac{5}{8}$ " | 80 lbs.    |

b. *Tube Complement, Vacuum.*

| TUBES             | COMMERCIAL TYPE DESIGNATION |
|-------------------|-----------------------------|
| 1 - Tube VT-116-A | RMA 6SJ7-GT                 |
| 1 - Tube VT-90-A  | RMA 6H6-GT                  |
| 1 - Tube VT-231   | RMA 6SN7-GT                 |
| 3 - Tube VT-115-A | RMA 6L6-G                   |
| 2 - Tube VT-244   | RMA 5U4-G                   |

c. *Rack Mounting.*—Removed from the cabinet, the recorder fits a standard 19 inch (relay) rack. The height of the panel is 8-¾ inches. Recorder, less cabinet, weighs 65 pounds.

d. *Supplementary Equipment.*—To operate the recorder, the following additional equipment is required:

1. ⅜-inch paper recorder tape as made by Link Paper Co. of New York, or equal.
2. Recorder Ink of appropriate type (see Par. 7g).

Note: Accessories are a pair of monitoring headphones, external key and Electronic Motor Control\*. These are not supplied with the instrument.

\*This is a special Waters Conley electronic device designed for plugging into socket (2744P) on back of recorder chassis by means of which recorder may be left in standby position. An incoming signal to be recorded will actuate the Electronic Motor Control which, in turn, will automatically put recorder into full operating position and recorder will then start recording without requiring manual control. When incoming signal terminates, the Electronic Motor Control will then automatically put recorder back into standby position.

3. **POWER SUPPLY.**—Recorder BC-1016 operates on 117-170-210-240-volt, 50-60-cycle alternating current. Voltage variations of 10 per cent will not affect its operation. Total power consumption is approximately 140 watts. Standby power consumption is approximately 85 watts.

4. **INPUT SIGNAL.**—The input signal required for operating the recorder is between, .15 and 50 volts. This signal may be obtained in either of two ways:

- a. From a radio receiver directly connected to the recorder.
- b. From a telephone line which carries the radio signals to the recorder from a remotely located radio receiver.

5. **ALTERNATIVE USE.**—Recorder BC-1016 can also be used for direct operation by a key, either manual or automatic. (See PAR. 7c (2).)

## SECTION II. INSTALLATION AND OPERATION

**6. UNPACKING.**—The complete recorder is packed in an individual carton. After opening the carton at the top, first remove the three narrow fitted cardboard blocking pieces from the two sides and back. Do not attempt to remove the wide cardboard blocking piece in front which protects ink mechanism and controls. After side and back cardboard blocking pieces have been removed, lift out the recorder cabinet and front cardboard blocking piece at same time.

### 7. INSTALLATION AND PREPARATION FOR USE

*a. Selection of Power Supply.*—Recorder is set at factory for operation on 117 volts, if operation on other voltage is desired, the following changes must be made: Located between the two Tubes VT-244 and accessible through the opening in the top of the cabinet is the a-c input switch (2745P, FIG. 2). Remove Tube VT-244 at the rear of the chassis. With a small screwdriver inserted through the grill on the rear of the cabinet, loosen the locking screw on the a-c input switch and turn the switch to required voltage position as marked on switch. When proper voltage setting has been made, tighten locking screw, and replace Tube VT-244.

*b. Selection of Proper Fuse.*—For operation on 117-170 volts, a 3-ampere protective fuse is used. For operation on 210-240 volts, this fuse must be changed to a 1½ ampere fuse. Remove the fuse holder cap (2740P, FIG. 2) on the rear of the chassis by pressing in and turning one-quarter turn in a counter-clockwise direction. Replace the 3-ampere fuse with the 1½ ampere fuse supplied and located in the tape drawer.

#### *c. Connecting the Input.*

(1) *Requirements.*—Recorder BC-1016 is designed to operate from a source of audio frequency code signals that meet the following requirements:

- (a). Frequency, 500 to 5,000 cycles per second.
- (b). Voltage, 0.3 volts to 50 volts (across two outside terminals of Recorder BC-1016 input).  
0.15 to 25 volts (across center terminal and either outside terminal of Recorder BC-1016 input).  
Normal operating range is from 2 to 5 volts and is not critical.
- (c). No direct current should be applied to the input of Recorder BC-1016.

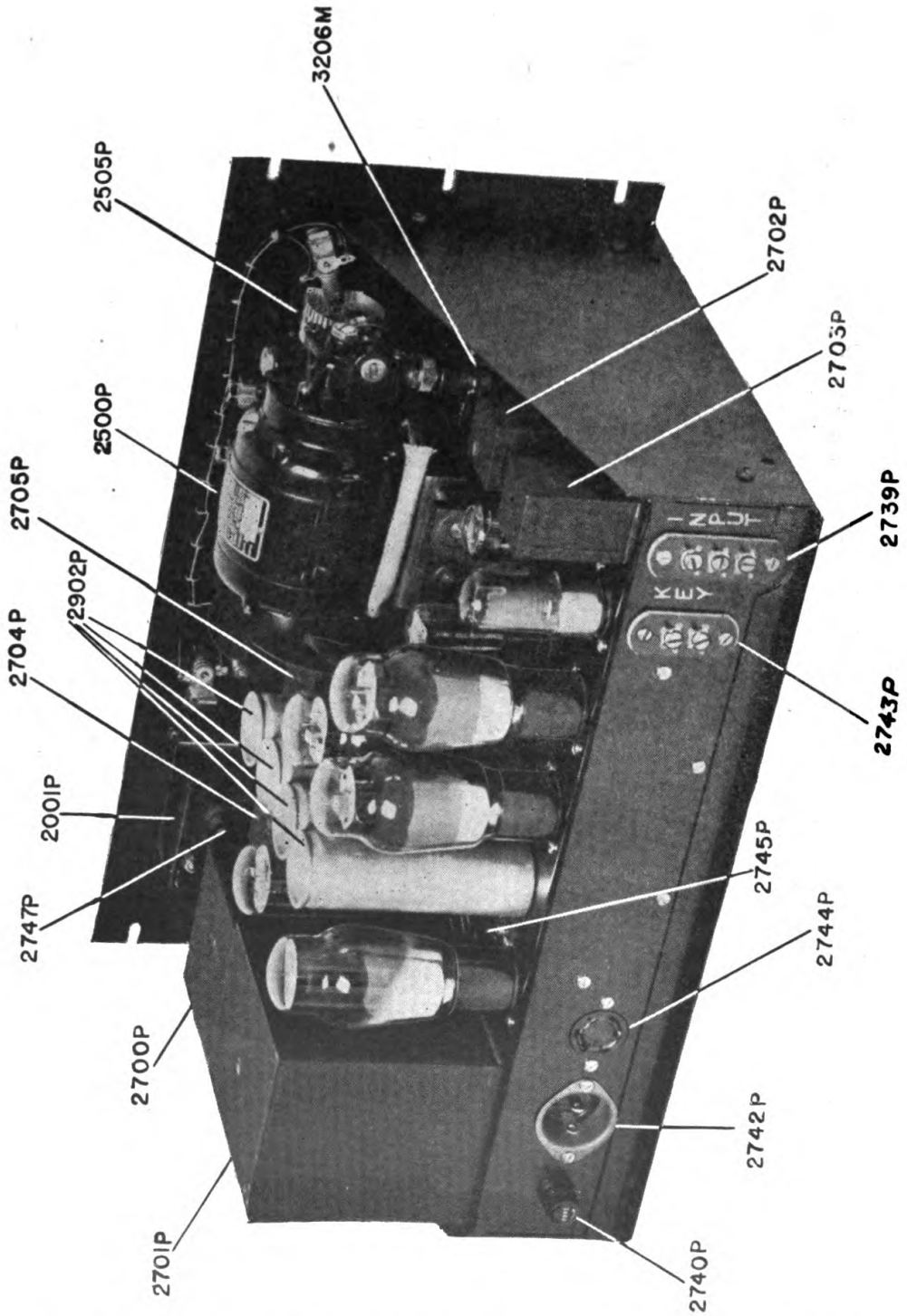


Figure 2—Recorder BC-1016, Rear View—Removed from Cabinet.

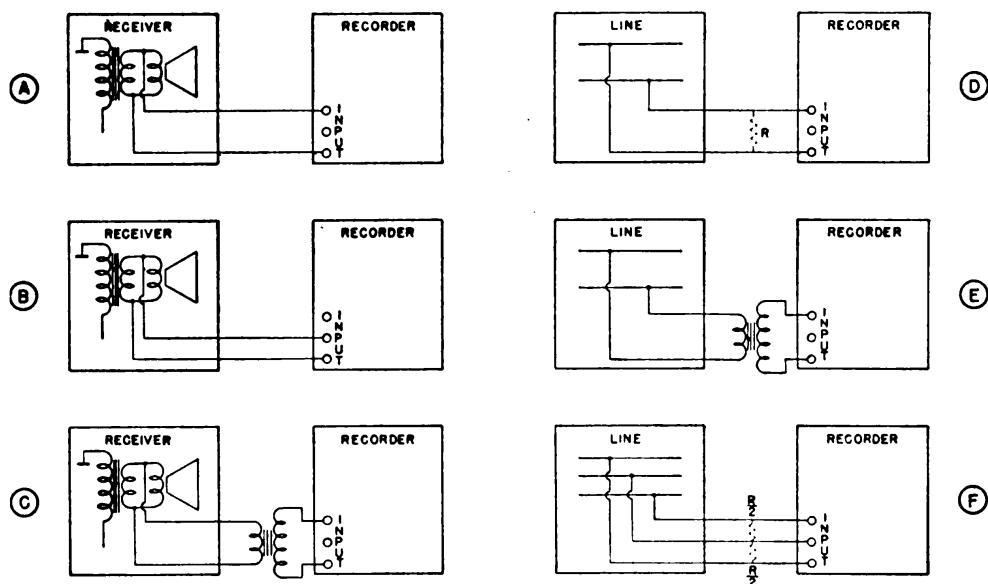
- (d). The actual impedance of the BC-1016 input is 5,000 ohms at 1,000 cycles measured across the two outside terminals. From the center terminal to either outside terminal measures 1,250 ohms at 1,000 cycles.

(Note: Ordinarily no attempt should be made to match this impedance. Recorder BC-1016 is primarily a bridging device.)

- (e). No ground to chassis is provided on the input strip. If desired, this connection may be made externally.

(2) *Direct Keying*.—To make a record of the sending of an operator using either automatic or hand keying, connect the key across terminals

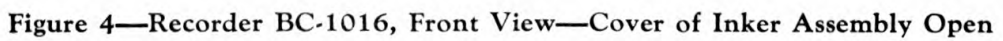
FIGURE 3 RECORDER B.C.1016 INPUT CONNECTIONS



(2743P, FIG. 2) on the rear of the chassis. No battery or oscillator is needed—closing the circuit keys the recorder. The monitor jack (2556P) and THRESHOLD control are out of service but the SLOPE control functions exactly as outlined in PAR. 8c.

(3) *Code Practice Oscillator*.—When it is desired to record code from a keyed audio oscillator, make sure that the requirements of PAR. 7c (1) as to frequency and output voltage are met by the oscillator. Then bridge the input of Recorder BC-1016 across the earphone or speaker connections. If direct current is present in the oscillator output, insert a suitable fixed condenser of from .1 to .25 mfd. in one lead to Recorder BC-1016.

(4) *Radio Receiver*.—A very important use of Recorder BC-1016 is the recording of high speed code signals from the output of a radio receiver. The input of the recorder may be connected to the receiver in a number of ways (FIG. 3). Use the one that suits your need best.



- (a). Normally, the input is connected directly across the voice coil of the loudspeaker, leaving the speaker connected so that the signals recorded are also heard from the speaker. This method is illustrated in FIG. 3 (A).
- (b). If additional sensitivity is required because the voice coil impedance is low or the receiver output is not enough to meet the requirements of PAR. 7c (1), connect as in PAR. 7c (4) (a) except use the center input terminal and either outside terminal. This is illustrated in FIG. 3 (B).
- (c). If still greater sensitivity is desired, a voltage step up transformer may be connected in the circuit as shown in FIG. 3 (C). A suitable transformer is the type known as "Line to Voice Coil." The ratio is usually about 10 to 1 and the low impedance side is bridged across the speaker voice coil.
- (d). On certain radio receivers Recorder BC-1016 may be operated from the phone jack. Be sure that the conditions of PAR. 7c (1) are met.
- (e). If a radio receiver is encountered that does not incorporate any output transformer or other output coupling device, a transformer which matches the output tube of the receiver must be inserted between the plate of the output tube and the input of Recorder BC-1016.
- (f). In all of the above methods, the loudspeaker is left in the circuit as a load for the receiver output. If this is unnecessary or undesirable, substitute a resistor equal in resistance value to the speaker voice coil impedance. The resistor must be large enough to handle safely the power output of the receiver. **CAUTION: Failure to provide a proper load for the receiver may damage the receiver.**

(5) *Audio Transmission Line.*—Often the source of audio code signals will be located at a remote point and a land (telephone) line used to bring the signal to the recorder. Recorder BC-1016 will function when connected to a line where the conditions of PAR. 7c (1) are met. The recorder is intended to be a bridging device and normally must not be considered as proper termination for a line. If no other termination is provided, a resistor (or resistors) must be connected as shown in the diagrams [FIG. 3 (D) and (F)]. The value of "R" will usually equal the impedance of the line.

(a). *Two Wire Line.*—Connect as shown in FIG. 3 (D).

(c). *Three Wire Balanced Line.*—The center terminal of Recorder BC-1016 input is a center tap on the input transformer. If the line is not otherwise terminated, connect two resistors each equal in resistance to one-half the line impedance in ohms, as indicated in FIG. 3 (F).

(6) *Keyer—Automatic.*—Recorder BC-1016 may be operated from the output terminals of several types of automatic keyers now in use. The instructions given in PAR. 7c (3) will apply.

d. *Wiring*

(1) *Table Mounting.*—If the recorder is to be operated on a table, place it in position and run leads from the appropriate input terminals (2739P, FIG. 2) to the radio receiver or transmission (telephone) line. Plug the line power cord into the receptacle (2742P, FIG. 2) on the rear of the chassis and into any convenient power outlet.

(2) *Rack Mounting.*—If recorder is to be mounted on a standard 19-inch (relay) rack, take the unit from the cabinet by removing the six screws (945P, FIG. 4) on the ends of the panel and the three screws holding the rear of the chassis to the bottom of the cabinet. The panel and chassis are rigidly fastened so that the recorder can be mounted by the same panel screws to the relay rack. When so mounted, hook up line cord and input leads as described in PAR. 7d (1).



e. *Tape Threading.*—(See FIGS. 4, 5, and 6.) Place a roll of tape in the tape drawer (3500S) so that as tape feeds the roll turns clockwise (to right). Pass the free end of the tape through the slit in the front panel of the drawer; close the drawer. Pass the tape to the right over roller [3718M (A)] and inside guide roller [3718M (B)] around roller [3718M (C)] and through the dust collector (3600S). Swing pen adjusting arm (3128M) out of the way to the left. Pass tape over adjustable roller (3148M) over tape anvil (3135M) over roller (3146M) and under roller (3719M). Move the pressure roller (3312M) upward and out of engagement with the tape drive roll (2515P) and pass the tape over the drive roll. Re-engage pressure roller.

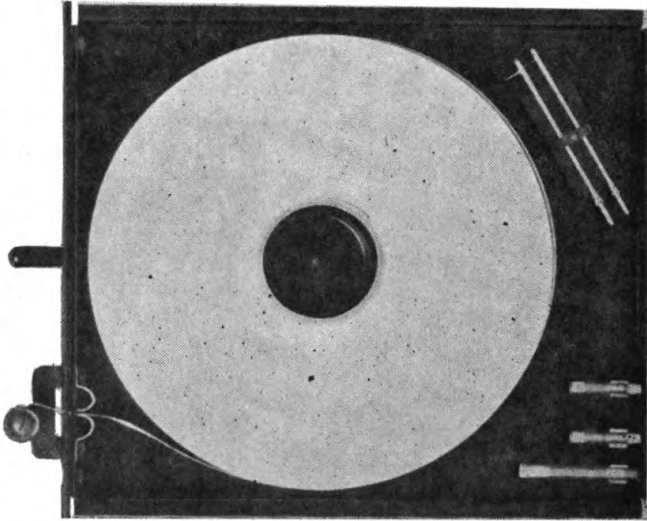


Figure 5—Recorder BC-1016, Tape Drawer With Tape Installed.

(Note: A panel light housing (3125, FIG. 6) is provided through which an electric lamp (2552P) illuminates the pen and tape while the recorder is in operation. If you ever have to operate the recorder continuously without general lighting, this lamp will enable you to do so.

It is not necessary to stop recorder operation to provide a continuous supply of tape. When more tape is needed as indicated by red color appearing on the white paper tape at end of roll, open tape drawer, remove remaining tape, put a new roll in tape drawer and paste beginning tape of new roll to the end of tape of the used-up roll. Be sure to paste the end of the new tape beneath the end of the old tape so the overlap will not catch on the end of the pen. Allow plenty of slack for making this joint. When tape puller has taken up most of the slack, close tape drawer.

f. *Locating Paper On Anvil.*—Adjustment knob (3151M, FIG. 6) on which tape guide roller (3148M, FIG. 6) is mounted controls the location of paper tape on the anvil. Paper tape may be moved to any desired location on the anvil by turning adjustment knob in proper direction as determined by corresponding movement of paper tape.

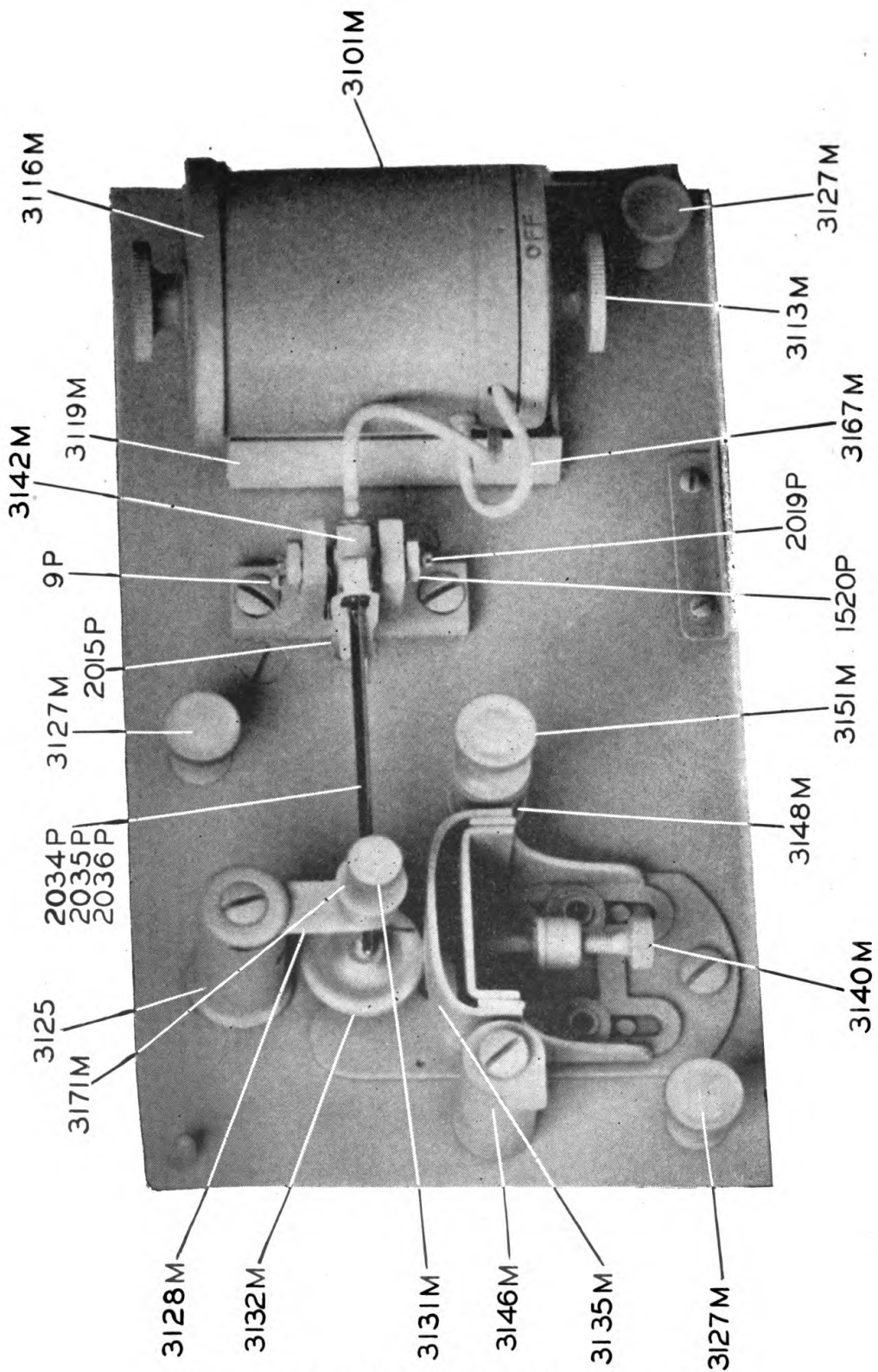


Figure 6—Recorder BC-1016, Inker Assembly.

(1) *Emergency Use Of Paper Tape.*—Ordinarily, just one centered recording is made on a roll of paper tape. To save tape in an emergency, two recordings can be made on one side of tape by decreasing pen swing width and locating first recording at lower edge of tape. After roll of tape has been run through recorder, rewind and rethread through recorder with used side of tape up. Then locate second recording just above center of tape and run through a second time. In extreme emergencies, the same roll of tape can be rewound and put through recorder a third and a fourth time using the other (blank) side of the paper tape. In such circumstances four recordings can be made on one roll of tape. This is equivalent to 4,000 feet of tape or, approximately eight hours operation at a tape speed of eight feet per minute on one roll of paper.

g. *Selecting Ink.*—(1) *Ink for High Speed Recording.*—High speed communication recording with the fine line pen calls for an ink in the form of a solution. Such an ink is Telegraph Blue issued in capsules (stock number 2Z7461/2) to be used with drying fluid issued with it (stock number 2Z7461/5).

(2) *Ink for Low Speed Recording.*—For low speed recording for instructional and training purposes a suspension type of ink is generally used, with the wide line pen. For this purpose you will be issued Higgins Eternal Black (stock number 6M615), or equal. Since the pen is apt to become clogged when this ink is used, refer to PAR. 7k (1), (2), and (3) for instructions for its use and for cleaning stopped up pens. **CAUTION: BE SURE THAT INK SUITABLE FOR THE USE TO WHICH THE RECORDER IS TO BE PUT IS AVAILABLE.**

h. *Selecting Pen.*—Three pens are supplied with each recorder (one installed and two in tape drawer, FIG. 5 and have the following applications:

(1) *Fine Line Pen (2036P).*—.015 inch line. Its use is primarily for communication purposes, that is, when the recording is made for visual reading. This pen should always be used for high speed recording with solution type ink [Telegraph Blue—see PAR. 7g (1)].

(2) *Medium Line Pen (2035P).*—.025 inch line. Its use is for all general recording exclusive of high speed signals, that is, below 200 words per minute. Solution type ink (Telegraph Blue) is recommended.

(3) *Wide Line Pen (2034P).*—.050 inch line. With the proper ink, [see PAR. 7g (2)] this pen is used at speeds less than 100 words per minute to produce the inked tape recording required for use with automatic photo cell keyers such as Keyer TG-34 or Keyer TG-10 which convert the ink record into an audible code signal.

i. *Inserting Pen.*—First lower tape anvil (3135M, FIG. 6) to at least 1/4 inch below pen point; swing pen adjusting arm (3128M, FIG. 6) out of the way to the left; select pen of appropriate width; hold pen (at pen point end) in left hand with point down and place other end of pen in pivot block (3142M, FIG. 6), sliding firmly into this block until collar on pen clears catch (2015P, FIG 6). At this point, pen catch holds pen securely in position in pivot block.

**CAUTION: Do not use too much pressure in inserting pen.** If pen is properly started in the pen block as described, the placement can be made readily despite tight sliding fit.

j. *Adjusting Pen Stop Screws.*—(FIG. 6) Two variable pen stop screws (3131M) and (3132M) are provided for adjustment of pen swing width. Rear stop (3132M) maintains its adjustment by means of spring tension, but the front stop (3131M) is securely held in place by the lock nut (3171M). The stops can be adjusted for a maximum pen swing of practically the entire width of the 3/8-inch tape. This extreme pen swing will rarely or never be used and should be avoided. It may be used only with low speed recording. As the speed of recording is increased, the width of pen swing must be decreased. The load on the driving mechanism is increased as width of pen swing increases. For longest life of the driving and pen mechanisms, keep pen swing within reasonable limits. Normal operation at reasonable speeds calls for the setting of stops for a pen swing of about 3/16 inch at the most.

k. *Inker Assembly.*—(FIG. 6) Before filling ink cup (3101M), make sure that manual pump operated by knurled knob (3113M) on bottom of cup is at OFF as indicated by arrow at lower edge, and that transflex ink tubing (3167M) is securely in place on both cup and pivot block connections. Fill ink cup with appropriate ink to about two-thirds full. After filling, replace cover loosely so as to allow air to enter cup. **CAUTION: Do not screw cup cover down tight when recorder is in operation or ink will not flow continuously due to lack of air pressure.** Turn manual pump clockwise (to right) until enough ink comes through pen point to form a blot on the tape. Use blotter to absorb excess ink.

(1) If recorder has been used previously and ink does not flow evenly, the pen may need cleaning. This can be done roughly by using a pen reamer (3713M, FIG. 5) to remove ink particles which may have clogged the pen point tube. These pen reamers are in the tape drawer. Periodically, the pen should be removed from recorder and washed in appropriate solution. For certain inks (Telegraph Blue), warm water is satisfactory. For other inks, a suitable solvent should be used.

(2) Leave pump at ON when recorder is in operation. If recorder is to be transported with ink in cup, remove ink in pen, transflex ink tubing and pen block by turning knurled knob on bottom of cup counter-clockwise (to the left) until ink has been pumped back into cup. Then leave pump at OFF and screw ink cup cover down tight. Suspension type inks have a tendency to precipitate solid matter. If ink of this type is left in the pen point for too long a period, such precipitation may occur and will necessitate cleaning of pen point. When recorder will not be used for a reasonable time, withdraw the ink from the pen and transflex tubing into the cup in the manner described above. This will reduce chances of the pen point becoming clogged. This precaution is not necessary when ink of the solution type such as Telegraph Blue is used.

(3) The ink cup can be raised by sliding it upwards in its bracket (3119M, FIG. 6). Ordinarily this is not necessary, but with certain suspension types of thick ink, (such as Higgins Eternal Black), especially when it is used with the wide line pen (which requires a more than normal flow of ink), better operation may be secured by raising the ink cup. This allows gravity to aid the normal ink flow due to capillary action. If ink flow is too free, lower the ink cup.

## 8. OPERATION.—(See FIG. 4 for control markings.)

a. *Start.*—Turn THRESHOLD (2895P), SLOPE (2896P), and discriminator (2542P) controls each to 0. Turn MASTER ON switch to ON and allow 30 seconds or so for tubes to reach operating temperatures. Turn MOTOR ON switch to ON and adjust tape anvil (3135M) by means of micrometer adjustment screw (3140M) until pen is drawing a continuous line. **CAUTION: Do not force anvil into pressure contact with pen point. Only very light contact is required.**

b. *Threshold.*—With tape running, advance the THRESHOLD control (2895P) clockwise (to the right) until the pen is moved by the input signal. This is the "threshold" point. The adjustment is not critical except at extremely high recording speeds or where there is a large noise component in total signal input. Best results under these conditions will be obtained if the THRESHOLD control is advanced just beyond the threshold point. If the input signal is fading, readjust the threshold control to secure a point which gives uninterrupted re-recording.

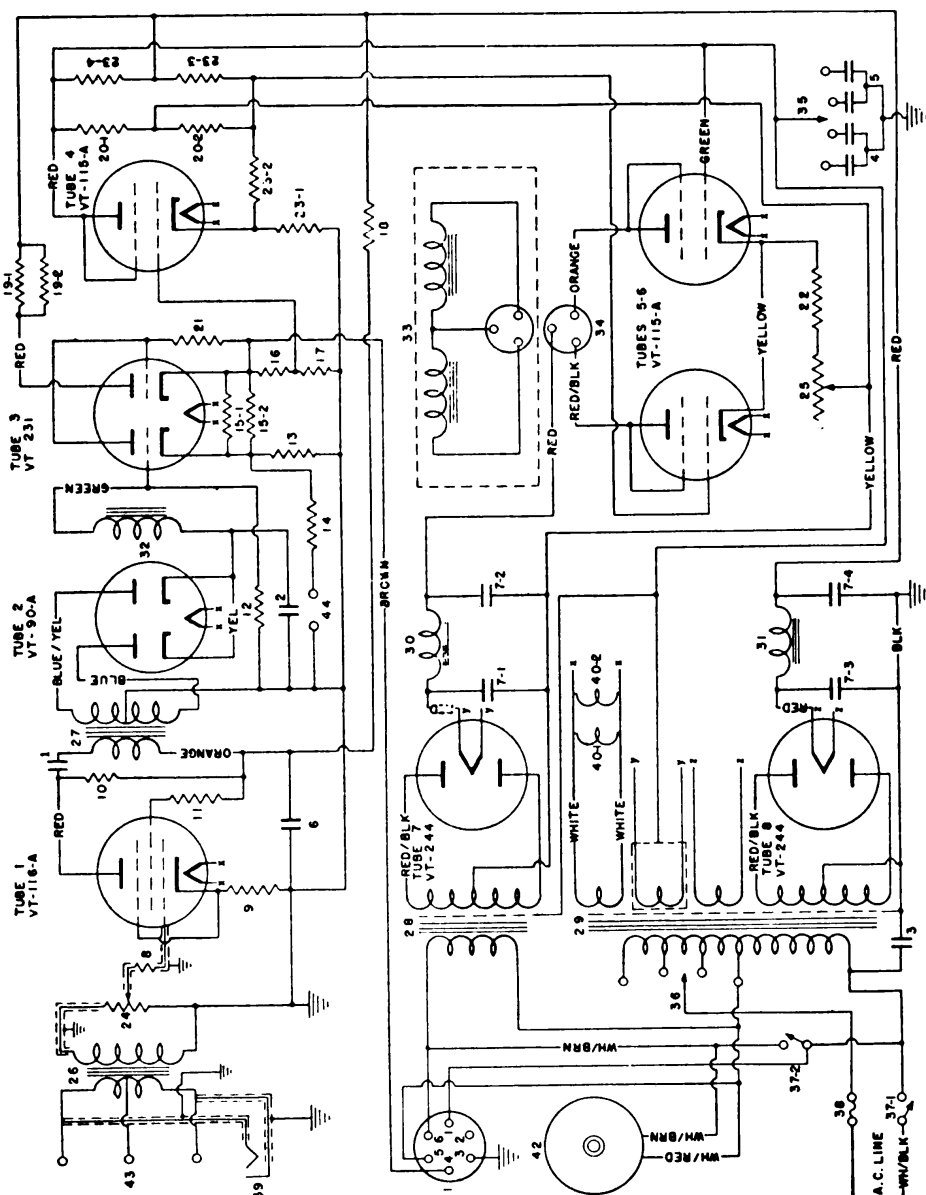
c. *Slope.*—The SLOPE control (2896P) governs the speed of the pen swing across the tape by varying the pen mechanism driving power. (Primarily the SLOPE control varies the slope of the "trace" which is the line between the "space" and the "mark".) If an irregular recording is being obtained due to insufficient pen action, advance this control. To prevent pounding and unnecessary wear on pen mechanism, keep the SLOPE control as close to 0 (zero) as possible. (For inter-relationship between effects of SLOPE and DISCRIMINATOR control settings, see PAR. 8d.)

d. *Discriminator.*—When short duration noise pulses, such as from ignition systems, etc., are big enough to be recorded on the tape as part of total signal record, the DISCRIMINATOR control (2542P) may be used to lessen or get rid of them. This control has five positions but should be left at 0 unless discrimination against noise is required for clean recording. If noise conditions are such as to require discrimination, the control should be advanced until clean recording results. Increasing DISCRIMINATOR control action lowers the top speed at which the recorder can function, so use it sparingly and only when necessary.

It is not good practice to set the DISCRIMINATOR control at a high position and then try to offset its effect by setting the SLOPE control high. The best method to follow is to balance on a *minimum setting* basis both DISCRIMINATOR and SLOPE controls to find the best settings for best performance under any particular set of operating conditions.

e. *Pivot Friction Spring.*—In rare instances of wide pen swing for special recording, irregular characters (markings) may result. If readjustment of controls fails to correct this condition, the pivot friction spring (2662P, FIG. 12) may be used. Loosen lock nut on pivot friction spring adjustment screw (1503P) and by rotation of the screw, adjust spring until you get clean characters. **CAUTION: Do not use this adjustment unless absolutely necessary, and when no longer required, back off adjustment screw enough to eliminate any action from the spring and lock it in this position.**

| Part No. | Name                          | Quant. |
|----------|-------------------------------|--------|
| 2903P    | Condenser .01 Mfd.            | 1      |
| 2907P    | Condenser .02 Mfd.            | 1      |
| 2904P    | Condenser .05 Mfd.            | 3      |
| 2906P    | Condenser .05 . . 1 Mfd.      | 4      |
| 2905P    | Condenser .2 . . 5 Mfd.       | 1      |
| 2901P    | Condenser 1 Mfd.              | 1      |
| 2902P    | Condenser 4 Mfd.              | 4      |
| 2809P    | Resistor 500,000 Ohm 1/2 Watt | 1      |
| 2802P    | Resistor 1,000 Ohm 1/2 Watt   | 1      |
| 2813P    | Resistor 500 Ohm 1/2 Watt     | 1      |
| 2808P    | Resistor 500 Ohm 1/2 Watt     | 1      |
| 2804P    | Resistor 120,000 Ohm 1/2 Watt | 1      |
| 2810P    | Resistor 20,000 Ohm 1/2 Watt  | 1      |
| 2814P    | Resistor 20,000 Ohm 1/2 Watt  | 1      |
| 2801P    | Resistor 1,000 Ohm 1/2 Watt   | 1      |
| 2812P    | Resistor 500 Ohm 1/2 Watt     | 1      |
| 2806P    | Resistor 20,000 Ohm 1/2 Watt  | 2      |
| 2805P    | Resistor 41,500 Ohm 1/2 Watt  | 1      |
| 2803P    | Resistor 12,000 Ohm 1/2 Watt  | 1      |
| 2811P    | Resistor 12,000 Ohm 1/2 Watt  | 2      |
| 2807P    | Resistor 75,000 Ohm 1/2 Watt  | 2      |
| 2814P    | Resistor 40,000 Ohm 1/2 Watt  | 1      |
| 2898P    | Resistor 500 Ohm 10 Watt      | 1      |
| 2937P    | Resistor 1,250 Ohm 4 Watt     | 1      |
| 2932P    | Resistor 4,000 Ohm 7 Watt     | 1      |
| 2933P    | Resistor 3,000 Ohm 6 Watt     | 1      |
| 2934P    | Resistor 20,000 Ohm 4 Watt    | 1      |
| 2895P    | Control 500,000 Ohm 1 Watt    | 1      |
| 2896P    | Control 1,100 Ohm 25 Watt     | 1      |
| 2703P    | Transformer, Input            | 1      |
| 2702P    | Transformer, Driver           | 1      |
| 2700P    | Transformer, Plate            | 1      |
| 2701P    | Transformer, Plate—File.      | 1      |
| 2704P    | Choke, Filter                 | 1      |
| 2705P    | Choke, Filter                 | 1      |
| 2706P    | Choke, Signal                 | 1      |
| 2001P    | Pen Drive Unit                | 1      |
| 2747P    | Pen Drive Unit Plug           | 1      |
| 2542P    | Rotary Switch                 | 35     |
| 2745P    | A.C. Rotary Switch            | 1      |
| 2541P    | Toggle Switch                 | 2      |
| 2554P    | Fuse                          | 1      |
| 2556P    | Jack                          | 1      |
| 2552P    | Pilot Lamps                   | 2      |
| 2744P    | 6-Prong Socket                | 1      |
| 2500P    | Motor                         | 1      |
| 2739P    | Input Terminal Strip          | 43     |
| 2743P    | Key Terminal Strip            | 44     |



**Figure 7—Recorder BC-1016, Schematic Diagram.**

f. *Tape Speed*.—The tape speed control knob (3226M), located in the left center of the front panel, controls the speed of the tape travel through the recorder. The illuminated indicator dial (2505P) is calibrated to show the speed of the tape through the recorder in feet per minute. (See FIG. 4.)

g. *Motor Switch*.—A separate motor switch, marked MOTOR-ON, is just to the left of the MASTER-ON switch on the front panel. When the operator is standing by for signal, he may turn off this motor switch (which also controls the pen driving circuits). This switch does not control tube filament circuit which is on when MASTER-ON switch is at ON.

9. **MONITORING**.—The input signal may be monitored by plugging a pair of standard high impedance headphones such as Headset P-18 or P-20 into the monitor jack (2556P, FIG. 4) provided for this purpose on the front panel. This jack is connected across the input terminals of the recorder.

### SECTION III. FUNCTIONING OF PARTS

*Note: The reference numbers in this section will be found on FIGS. 7, 8, and 9.*

10. **GENERAL**.—The recorded signal as it appears on the 3/8-inch paper tape used in the recorder although essentially representing the dots and dashes of the code signal transmitted, takes the form of a square wave. This recorded signal can be read visually by those who have learned the method; or, in some instances, the 3/8-inch tape on which the ink record is made can be passed through a keyer which converts the written signal into an audible signal which the operator decodes in the conventional manner. Recorder BC-1016 was designed to make ink records of code signals on 3/8-inch paper tape at relatively high speeds with a fine line pen used in communication work where the tape is read visually. It was also designed to make ink records at relatively slow speeds with a heavy line pen to be used in connection with a keyer (such as Keyer TG-10 and Keyer TG-34) for conversion of the ink record into an audible signal to be decoded by the operator in the conventional manner.

11. **POWER SUPPLY CIRCUITS**.—The a-c line voltage is applied to the primary of the plate and filament transformer (29) through the MASTER-ON switch (37-1), the fuse (38) and the a-c line voltage switch (36). When the line voltage switch is in other than the 117-volt position, the primary winding of the transformer is used as an auto-transformer, to make available 117 volts for the motor (42) and for the primary of the plate transformer (28). Transformer 29 supplies the heater voltages to all tubes and also the high voltage alternating current to the full wave rectifier tube (8). This rectifier tube together with its associated filter components, filter choke 31 and capacitor 7-3 and 7-4, supplies the necessary high voltage direct current to tubes 1, 3, and 4.

a. **MOTOR-ON switch (37-2)** enables the motor (42) and plate transformer (28) to be switched off independently of the rest of the unit. This switch is paralleled by contacts 1 and 6 of socket 41, thereby making provision for remote control of these circuits.

The secondary of plate transformer (28) supplies high voltage alternating current to rectifier tube (7). This rectifier tube together with its associated filter components, filter choke 30 and capacitors 7-1 and 7-2, supplies high voltage direct current to tubes 5 and 6.

**12. SIGNAL CIRCUITS.**—Audio code signals from the output of a radio receiver, audio frequency transmission line, or code practice oscillator are fed to the primary of the center tapped input transformer (26) by connection to input terminals (43). A headphone jack (39) is also connected across this input for

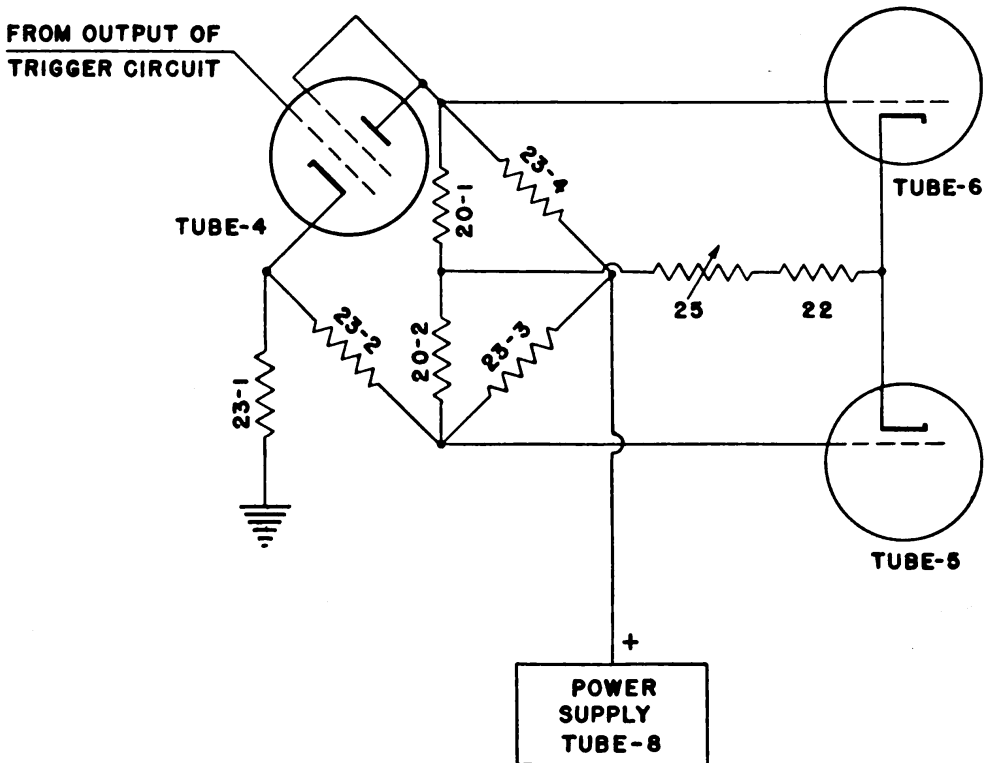


Figure 9—Recorder BC-1016, Bridge Circuit Shown in Detail

purposes of monitoring when desired. The input transformer (26) is a line to grid type with a primary to secondary turns ratio of 1:10. The THRESHOLD control (24) connected across the secondary winding of this transformer varies the percentage of input signal which is applied to the grid of tube 1. This tube serves a dual purpose as an amplifier of small input voltages and as a limiter of larger voltages, so that the output of this tube remains substantially constant as the input signal varies in amplitude within the limits of recorder operation.

a. This limiting action is accomplished in several ways: First, because of the signal voltage drop across the grid resistor (8) when the signal voltage exceeds that of the grid bias of the tube; second, through degeneration in the cathode and screen circuits, and third, because of the relatively low load impedance in the plate circuit of this tube.



b. Driver transformer 27 is a conventional plate to push-pull grid transformer with a low primary inductance and a primary-to-secondary turns ratio of 1:2. It is utilized in this case to feed the signal voltage to the two plates of the full wave signal rectifier tube 2. The output of this rectifier is then filtered by means of capacitor 2 and signal choke 32. Up to the input of this rectifier and filter system the dots and dashes of the code signal have retained the characteristics of an audio signal. The output of this rectifier and filter circuit is direct current, each dot or dash producing a d-c voltage across resistor 12. The time lag in the signal filter circuit delays the instantaneous starting and stopping of each dot and dash which results in an output voltage having a wave form similar to that shown in FIG. 8. This is not suitable for proper recording. The trigger tube (3) converts this to a voltage which is substantially square in wave form.

c. Tube 4 forms one arm of a bridge circuit, the other three arms being resistors 23-2, 23-3 and 23-4. This is shown in detail in FIG. 9. The voltage

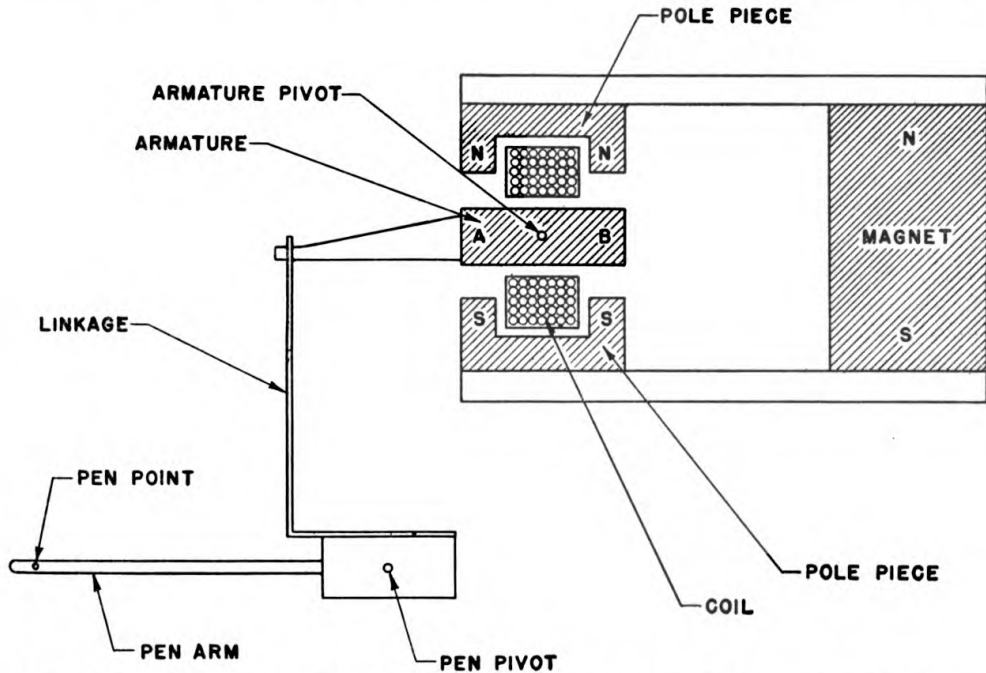


Figure 10—Recorder BC-1016, Pen Drive Unit—Operational Diagram.

variations across the output of this bridge circuit are center tapped by resistors 20-1 and 20-2 thus providing equal but opposite voltages from the center tap to the ends of these resistors.

d. Upon application of signal to the grid of tube 4 the balance of this bridge is such that one end of the output and consequently the grid of one pen driving amplifier becomes negative and upon removal of the signal this same end becomes positive.

e. During the time when no signal is received at the recorder input the resultant bias on the grid of tube 6 is negative to the point of cut off so that no current flows in its plate circuit. At the same time, tube 5 is biased to a very low negative value and current flows in its plate circuit through one half of the coil of the pen drive unit (33). Under these conditions the armature is so polarized that end A is north and B is south (FIG. 10). The resulting magnetic force moves the pen away from the panel to what is known as the space side of the tape.

f. When a signal is applied to the input of the recorder the above action takes place in the opposite direction, the grid of tube 5 being negatively biased to a high value and that of tube 6 to a low value. Current then flows in the plate circuit of tube 6 and through the opposite half of the coil of pen drive unit (33). This reverses the polarity of the armature so that end A is south and B is north (FIG. 10), and the pen moves toward the panel to the mark position.

**13. SLOPE CONTROL.**—The SLOPE control (25) functions to adjust the minimum bias voltage on the grids of the pen driving amplifier tubes (5 and 6), varying the amount of current which flows in the anode circuits of these tubes and, consequently, the amount of power the pen drive unit receives. The rate of travel of the pen across the surface of the tape is determined by the amount of power applied to the pen drive unit; it is possible to vary the slope of the characters by means of this control.

**14. DISCRIMINATOR.**—The action of the discriminator circuit is such that it by-passes signals of exceedingly short duration and makes the recorder insensitive to them, so that certain types of interference such as ignition noise do not actuate the pen. This is accomplished by the capacitors 4 and 5 which are connected between the plate of tube 4 and ground, the actual capacity in use depending upon the amount of discrimination required.

**15. KEY.**—The key terminals (44) are arranged so that the closing of the key removes the bias from the input grid of tube 3. This initiates the same trigger action as results from the application of a signal to the recorder input.

## SECTION IV. MAINTENANCE

**CAUTION! PERSONNEL WITH INSUFFICIENT TRAINING OR INCOMPLETELY EQUIPPED WITH PROPER TOOLS AND INSTRUMENTS MUST NOT ATTEMPT TO MAKE ANY REPAIRS OR OTHER THAN OPERATING ADJUSTMENTS TO THIS RECORDER!**

**16. MAINTENANCE PARTS GROUPS (OR KITS).**—Two sets of Maintenance Parts Groups or Kits are available as follows:

*a. Individual.*—This is a small group of maintenance parts designed to accompany each recorder shipped out for use, to provide a supply of those parts most subject to normal wear in recorder operation, at the point of such operation. The repairs or replacements requiring the parts comprising the Individual Parts Group are readily made by the recorder operator or by any repairman of reasonable skill and experience. A list of the parts and quantities of each part comprising this individual group is given in TABLE 2.

*b. Master.*—This is a complete group of maintenance parts to be kept at base repair and maintenance depots. The list has been designed to provide parts for repairs requiring special skill or equipment which may not be available at the point of operation of the recorder. It is also designed to include those items which are not ordinarily subject to short time replacement because of normal wear but which for other reasons may require replacement from time to time. The Master Kit will also serve as a stock source in storage and warehouse depots, from which parts included in the individual group and used up may be replenished. The items comprising each Master Kit have been calculated on the basis of one Master Kit to 20 recorders in use. A list of the parts and quantities of each part comprising the Master Kit is given in TABLE 3.

**17. LUBRICATION.**—(See FIG. 11.)

*a.* Apply a small amount of light grease occasionally to the speed control screw (3207M) and to the associated motor base rods (3205M). Lubricate the speed control screw bearings with a light mineral oil through the oil ducts (L) on each end.

*b.* The tape drive shaft (3217M) is equipped with porous bronze bearings (2503P) which require lubrication with a light mineral oil at infrequent intervals.

*c.* Since the guide rollers and the pressure roller operate at very low speeds, little attention need be paid to them other than lubricating with Waters Conley general purpose lubricant (2960) or with a good quality light mineral oil, as needed.

*d.* Lubrication of the motor under normal conditions will not be necessary. If recorder is to be operated where temperatures are lower than 0° F., the grease in the gear housing and bearings must be removed and replaced with Beacon Lubricant M-285 (or equivalent). A 1/2 ounce tube of Beacon Lubricant M-285, enough for one replacement, is supplied for this purpose with each recorder.

(1) Replacement of grease in motor requires the complete removal of entire drive assembly from recorder. Remove tape speed control knob (3226M) and tape drive roll (2515P) as described in PAR. 18 and also the two electrical connections to motor. Remove the four motor and drive assembly mounting screws which

are accessible from underside of chassis. The motor itself may then be removed from drive assembly by removing the four motor mounting screws and friction drive plate (3206M). To remove drive plate from slow speed motor shaft, loosen set screw. Gear housing may then be removed from motor by removing the three screws. The gear housing can then be repacked with appropriate grease.

e. A very small amount of pure light mineral oil should occasionally be applied to the pen pivot screw points (2019P, FIG. 12).

**18. TAPE DRIVE ROLL.**—A supply of rubber tape drive rolls (2515P) is included in the individual maintenance kit. To replace, remove the acorn nut on the front of the roll and take off the outer washer. The rubber roll can then be removed and a new one installed.

**19. FRICTION DRIVE.**—(See FIG. 11.) An adjustment (2650P) is provided for maintaining tension of driven wheel against drive plate (3206M) to compensate for normal wear of neoprene ring (2516P). **CAUTION: Be careful to maintain just enough tension by this adjustment, to provide smooth puller action.** Too much tension will result in needless wear of neoprene ring.

a. A supply of neoprene rings (2516P) is included in the individual maintenance kit. To make replacement, release the set screw on the friction driven wheel hub and those on the two retaining collars (3220M). The entire shaft may then be pulled forward and the driven wheel assembly will be released. After removing the nut, lock washer and outer wheel disc of the driven wheel assembly, the neoprene ring may be removed and replacement made. In reassembly, be sure to have the pressure roller (3312M) properly centered with the tape drive roll (2515P). Set the retaining collars properly to avoid both excessive end play in, or binding of, the puller shaft.

b. Resetting of tape drive elements for correct reading of tape speed indicator is secured by proper placement of friction drive wheel on shaft. This can be checked by setting at a medium speed and running through tape for 30 seconds or so to determine length of tape out of recorder.

c. Occasionally, the driven wheel and friction drive plate should be cleaned with a suitable solvent, such as benzene, to remove any oily film which may have accumulated. **CAUTION: Do not use abrasives of any kind on the face of the drive plate. If you do, you may cause the neoprene ring to wear out and drive plate may have to be replaced.**

**20. INKER ASSEMBLY.**—(See FIGS. 12 and 13.) For servicing or replacement, the complete inker assembly may be removed from the recorder by loosening the three knurled fastening screws (3127M) on the (plated) inker panel and then disconnecting the separable attachment plug (2747P) at the rear.

*a. Bumper Inserts.*—Extra plastic bumper inserts (3166M) are supplied in the individual maintenance kit. Replace these inserts as required to prevent any metallic contact between the pen and pen stop screws, which will damage the pen. Apply a small amount of collodion cement to the end of the bumper inserts before insertion.

*b. Pivot Screws.*—Check the adjustment of pen pivot screws (2019P) occasionally. The best setting is that at which no vertical movement of the pen exists and yet no binding action is present to interfere with the normal horizontal swing of the pen. Make adjustment carefully with small blade screwdriver after releasing pivot lock nuts (1520P). When adjustment has been completed, re-tighten lock nuts carefully and securely.

*c. Pivot Block Assembly.*—*Note:* It is not recommended that pivot block assembly (3753M) be replaced except at a well equipped base repair station. Preferably, replace entire inker assembly and return unit to base for servicing. If it is necessary in an emergency to make such repair, proceed as follows: Remove pen, pen pivot screws (2019P) and transflex ink tubing (3167M) from pivot block. Remove pen drive unit (2001P) cover at the rear, and unsolder silvered beryllium copper link from armature of pen drive unit. Reassemble by replacing pen and pivot screws and ink tubing. Then make adjustments of pivot screw settings as described in PAR. 19b. Before resoldering beryllium copper link to drive unit armature, screw up pen stops to hold pen firmly and parallel to the inker panel. Shunt across magnetic poles of pen drive unit with soft iron or steel slugs so that drive arm assumes a center position; set adjusting screw on top side of drive unit so that screw slot is parallel to panel. Resolder link to drive arm, using just enough solder to completely fill slit in link, and being careful to keep link at right angles to panel. Remove magnetic shunts and replace cover. Install inker panel on recorder which is connected to source of normal signal input. With slope control at zero and pen stops set for 1/4" to 3/16" swing, operate the recorder and turn adjusting screw first to left and then to right so pen has tendency to hold first to one edge of tape and then to other edge. Make final adjustment midway between these two for correct operating center. *Note:* This adjustment becomes more critical at higher recording speeds.

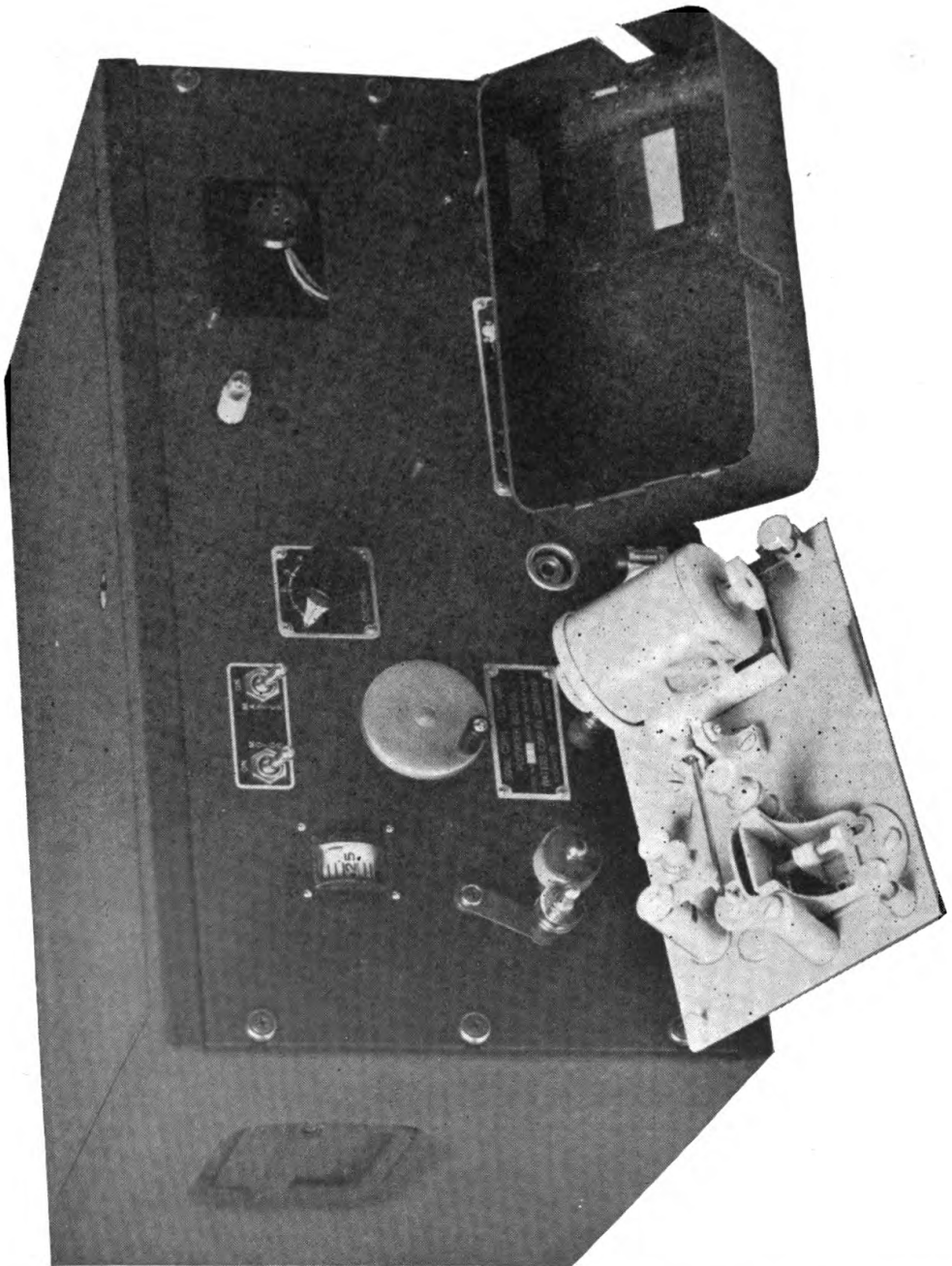


Figure 13—Recorder BC-1016, Front View With Inker Assembly Removed.

*d. Ink Tubing.*—Should it become necessary to replace the transflex ink tubing (3167M), remove the cup (3101M) from its bracket (3119M) by sliding upward and empty all ink. Release the set screw in the knob (3113M) of the manual pump at the bottom of the cup. This will allow removal of knob and dial. The locating spring, control plate bearing, and pump roller inside the pump may then be removed, and the transflex ink tubing replaced. (Before reassembling, apply a small amount of general-purpose lubricant (2960) or a good quality light grease to the moving parts of the pump.) The end of the transflex ink tubing which enters the pump at the front is fastened to the ink hose fitting on the ink cup.

*e. Ink Cup.*—Occasionally remove the ink cup (3101M) and ink tubing (3167M) from the recorder, empty them and wash with warm water or a solvent suitable for the type of ink used to remove sediment which tends to clog fittings, tubing and pen and prevent proper flow of ink. Neoprene gaskets for cup cover to prevent leakage of ink during transportation of recorder are supplied in the maintenance kit for replacement as needed.

**21. FUSE.**—If recorder fails to operate when turned on, remove the fuse as described in PAR. 7b; if it is defective, replace it with a new fuse of rating suited to operating line voltage.

*(Note: If the fuse blows during operation, check the recorder to determine the fault and correct it before replacing fuse.)*

**22. TUBES.**—A possible source of trouble is a defective or burned out tube. If the recorder fails to operate properly, check the tubes in a standard tube tester and replace any tubes found to be defective.

**CAUTION:** Check all tubes periodically.

**23. ELECTRICAL CIRCUIT.**—FIG. 7 is a schematic diagram of the recorder with appropriate legends describing the circuit components and giving their part numbers. This same diagram is also attached to the bottom plate of the chassis. FIG. 19 is a wiring diagram of the recorder with explanatory captions. TABLE 1 shows normal approximate voltages between the socket pins as indicated on a 20,000 ohm per volt voltmeter such as analyzer, Weston 772 or equal, part of RC-68 stock 3F 1772. The readings are taken with (1) normal line voltage, (2) MASTER-ON and MOTOR-ON switches at ON, (3) SLOPE and THRESHOLD controls full on, (4) DISCRIMINATOR control at 0 (5) audio test oscillator adjusted to 1000 cycles connected to the input terminals and alternately turned on and off.



TABLE 1.—AVERAGE TUBE VOLTAGES

| TUBE |          | FILAMENT |       | PLATE                                                  |       | GRID |       | SCREEN        |       | CATHODE |       | INPUT     |        |
|------|----------|----------|-------|--------------------------------------------------------|-------|------|-------|---------------|-------|---------|-------|-----------|--------|
| No.  | Type     | Pins     | Volts | Pins                                                   | Volts | Pins | Volts | Pins          | Volts | Pins    | Volts | No Signal | Signal |
| 1    | VT-116-A | 2-7      | 6.2   | 5-8                                                    | 188   | -    | -     | 5-6           | 105   | 5-Gnd.  | 3.6   | x         |        |
| 1    | VT-116-A | 2-7      | 6.2   | 5-8                                                    | 210   | -    | -     | 5-6           | 138   | 5-Gnd.  | 3.2   |           | x      |
| 2    | VT-90-A  | 2-7      | 6.2   | -                                                      | -     | -    | -     | -             | -     | 8-Gnd.  | 0     | x         |        |
| 2    | VT-90-A  | 2-7      | 6.2   | -                                                      | -     | -    | -     | -             | -     | 8-Gnd.  | 2     |           | x      |
| 3    | VT-231   | 7-8      | 6.2   | 2-3                                                    | 84    | 1-3  | 8.1   | -             | -     | -       | -     | x         |        |
| 3    | VT-231   | 7-8      | 6.2   | 2-3                                                    | 0     | 1-3  | 0     | -             | -     | -       | -     |           | x      |
| 3    | VT-231   | 7-8      | 6.2   | 5-6                                                    | 91    | 4-6  | .4    | -             | -     | -       | -     | x         |        |
| 3    | VT-231   | 7-8      | 6.2   | 5-6                                                    | 236   | 4-6  | 12    | -             | -     | -       | -     |           |        |
| 4    | VT-115-A | 2-7      | 6.2   | 3-8                                                    | 41    | 5-8  | 1.6   | -             | -     | -       | -     | x         |        |
| 4    | VT-115-A | 2-7      | 6.2   | 3-8                                                    | 195   | 5-8  | 34    | -             | -     | -       | -     |           |        |
| 5    | VT-115-A | 2-7      | 6.2   | 3-8                                                    | 215   | 5-8  | 82    | -             | -     | -       | -     | x         |        |
| 5    | VT-115-A | 2-7      | 6.2   | 3-8                                                    | 203   | 5-8  | 7.5   | -             | -     | -       | -     |           | x      |
| 6    | VT-115-A | 2-7      | 6.2   | 3-8                                                    | 203   | 5-8  | 7.5   | -             | -     | -       | -     | x         |        |
| 6    | VT-115-A | 2-7      | 6.2   | 3-8                                                    | 215   | 5-8  | 82    | -             | -     | -       | -     |           | x      |
| 7    | VT-244   | 2-8      | 5     | Filament to slope control moving contact - - 280 Volts |       |      |       | - - 280 Volts |       |         |       |           |        |
| 8    | VT-244   | 2-8      | 5     | Filament to Ground - - 280 Volts                       |       |      |       | - - 280 Volts |       |         |       |           |        |

**TABLE 2—Individual Maintenance Parts Group  
W-C Part 3775S**

| <i>Quantity</i> | <i>Part No.</i> | <i>Part Name</i>                                   |
|-----------------|-----------------|----------------------------------------------------|
| 1 .....         | 2515P .....     | Gum Rubber Tape Roll                               |
| 1 .....         | 2516P .....     | Driven Ring (Neoprene)                             |
| 1 .....         | 2801P .....     | 500 ohm, 1/2 Watt Resistor                         |
| 1 .....         | 2802P .....     | 1000 ohm, 1/2 Watt Resistor                        |
| 1 .....         | 2803P .....     | 10,000 ohm, 1/2 Watt Resistor                      |
| 1 .....         | 2804P .....     | 20,000 ohm, 1/2 Watt Resistor                      |
| 1 .....         | 2805P .....     | 41,500 ohm, 1/2 Watt Resistor                      |
| 1 .....         | 2806P .....     | 50,000 ohm, 1/2 Watt Resistor                      |
| 2 .....         | 2807P .....     | 75,000 ohm, 1/2 Watt Resistor                      |
| 1 .....         | 2808P .....     | 120,000 ohm, 1/2 Watt Resistor                     |
| 1 .....         | 2809P .....     | 500,000 ohm, 1/2 Watt Resistor                     |
| 1 .....         | 2810P .....     | 1,100 ohm, 1 Watt Resistor                         |
| 2 .....         | 2811P .....     | 12,000 ohm, 1 Watt Resistor                        |
| 2 .....         | 2812P .....     | 20,000 ohm, 1 Watt Resistor                        |
| 1 .....         | 2813P .....     | 5,000 ohm, 1/2 Watt Resistor                       |
| 1 .....         | 2814P .....     | 40,000 ohm, 1/2 Watt Resistor                      |
| 1 .....         | 2897P .....     | 4-Section Strip Resistor                           |
| 1 .....         | 2898P .....     | 500 ohm Strip Resistor                             |
| 1 .....         | 2895P .....     | Carbon Control (500,000 ohm)                       |
| 1 .....         | 2903P .....     | Capacitor - Oil Filled - .01 mfd.                  |
| 1 .....         | 2904P .....     | Capacitor - Oil Filled - .06 mfd.                  |
| 1 .....         | 2907P .....     | Capacitor - Oil Filled - .02 mfd.                  |
| 1 .....         | 2901P .....     | Capacitor - Oil Filled - 1 mfd.                    |
| 1 .....         | 2902P .....     | Capacitor - Oil Filled - 4 mfd.                    |
| 1 .....         | 2541P .....     | D. P. S. T. Toggle Switch                          |
| 1 .....         | 2034P .....     | Pen (Wide)                                         |
| 1 .....         | 2035P .....     | Pen (Medium)                                       |
| 1 .....         | 2036P .....     | Pen (Fine)                                         |
| 1 .....         | 2004P .....     | Ink Cup Gasket Only                                |
| 2 .....         | 3167M .....     | Ink Tube Only                                      |
| 8 .....         | 3166M .....     | Bumper Insert                                      |
| 1 .....         | 3754M .....     | Box Fuses (3-3A, 2-1.5A to box)                    |
| 1 .....         | 3756M .....     | Pen Reamers (3 in tube)                            |
| 1 .....         | 2970P .....     | End Wrench, 5/16 x 3/8                             |
| 1 .....         | 2971P .....     | No. 6 Allen Wrench                                 |
| 1 .....         | 2972P .....     | No. 8 Allen Wrench                                 |
| 1 .....         | 2973P .....     | Small Screw Driver                                 |
| 2 .....         | 2552P .....     | Pilot Bulb                                         |
| 1 .....         | 2960P .....     | Lubricant - General Purpose                        |
| 1 .....         | 2961P .....     | Lubricant - Motor                                  |
| 2 .....         | 2019P .....     | Pivot Screw                                        |
| 2 .....         | 1520P .....     | Pivot Screw - Nut                                  |
| 1 .....         | 3753M .....     | Pivot Block Assembly<br>(Complete with Drive Rods) |
| 5 .....         | 2999P .....     | Blotter Pad                                        |

**TABLE 3—Master Maintenance Parts Group  
W-C Part 3750S**

| <i>Quantity</i> | <i>Part No.</i> | <i>Part Name</i>                                          |
|-----------------|-----------------|-----------------------------------------------------------|
| 2               | 2500P           | Drive Motor                                               |
| 20              | 2515P           | Gum Rubber Drive Roll                                     |
| 1               | 2700P           | Plate Transformer                                         |
| 1               | 2701P           | Plate & Filament Transformer                              |
| 1               | 2702P           | Driver Transformer                                        |
| 1               | 2703P           | Input Transformer                                         |
| 1               | 2704P           | Filter Choke                                              |
| 1               | 2705P           | Filter Choke                                              |
| 1               | 2706P           | Signal Choke                                              |
| 20              | 2516P           | Driven Ring (Neoprene)                                    |
| 2               | 3206M           | Drive Disc (Cast)                                         |
| 15              | 2557P           | Knob                                                      |
| 2               | 2801P           | 500 ohm 1/2 Watt Resistor                                 |
| 2               | 2802P           | 1000 ohm 1/2 Watt Resistor                                |
| 2               | 2803P           | 10,000 ohm 1/2 Watt Resistor                              |
| 2               | 2804P           | 20,000 ohm 1/2 Watt Resistor                              |
| 2               | 2805P           | 41,500 ohm 1/2 Watt Resistor                              |
| 2               | 2806P           | 50,000 ohm 1/2 Watt Resistor                              |
| 4               | 2807P           | 75,000 ohm 1/2 Watt Resistor                              |
| 2               | 2808P           | 120,000 ohm 1/2 Watt Resistor                             |
| 2               | 2809P           | 500,000 ohm 1/2 Watt Resistor                             |
| 2               | 2810P           | 1,100 ohm 1 Watt Resistor                                 |
| 4               | 2811P           | 12,000 ohm 1 Watt Resistor                                |
| 4               | 2812P           | 20,000 ohm 1 Watt Resistor                                |
| 2               | 2813P           | 5,000 ohm 1/2 Watt Resistor                               |
| 2               | 2814P           | 40,000 ohm 1/2 Watt Resistor                              |
| 2               | 2897P           | 4-Section Strip Resistor                                  |
| 2               | 2898P           | 500 ohm Strip Resistor                                    |
| 4               | 2895P           | Carbon Control (500,000 ohm)                              |
| 4               | 2901P           | Capacitor - Oil Filled - 1 mfd.                           |
| 6               | 2902P           | Capacitor - Oil Filled - 4 mfd.                           |
| 5               | 2903P           | Capacitor - Oil Filled - .01 mfd.                         |
| 5               | 2904P           | Capacitor - Oil Filled - .06 mfd.                         |
| 5               | 2907P           | Capacitor - Oil Filled - .02 mfd.                         |
| 3               | 2905P           | Dual Capacitor - Oil Filled,<br>.5 x .2 mfd.              |
| 3               | 2906P           | Dual Capacitor - Oil Filled,<br>.1 x .05 mfd.             |
| 10              | 2541P           | D. P. S. T. Toggle Switch                                 |
| 5               | 2542P           | 5-Position Rotary Switch                                  |
| 4               | 3712M           | AC Line Cord                                              |
| 20              | 3230M           | Speed Dial Cord                                           |
| 4               | 3100S           | Complete Pen Drive Assembly<br>(With cover but less pens) |
| 10              | 2034P           | Pen (Wide)                                                |

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| Quantity | Part No. | Part Name                                       |
|----------|----------|-------------------------------------------------|
| 10       | 2035P    | Pen (Medium)                                    |
| 10       | 2036P    | Pen (Fine)                                      |
| 2        | 3751M    | Ink Cup Assembly (Complete)                     |
| 10       | 2004P    | Ink Cup Gasket Only                             |
| 20       | 3167M    | Ink Tube Only                                   |
| 2        | 3752M    | Ink Cup Cover Only (Complete)                   |
| 20       | 2019P    | Pivot Screw                                     |
| 20       | 1520P    | Pivot Screw Nut                                 |
| 20       | 3753M    | Pivot Block Assembly (Complete with Drive Rods) |
| 10       | 3135M    | Anvil Plate                                     |
| 10       | 3131M    | Stop Screw (Front)                              |
| 10       | 3132M    | Stop Screw (Back)                               |
| 20       | 3166M    | Bumper Insert                                   |
| 10       | 3754M    | Box Fuses (3-3A, 2-1.5A to box)                 |
| 2        | 3755M    | Springs (5 assorted)                            |
| 20       | 2992P    | Brush                                           |
| 10       | 3796M    | Pen Reamers (3 in tube)                         |
| 2        | 3757M    | Screw Assortment                                |
| 2        | 2970P    | End Wrench - 5/16 x 3/8                         |
| 2        | 2971P    | No. 6 Allen Wrench                              |
| 2        | 2972P    | No. 8 Allen Wrench                              |
| 2        | 2973P    | Small Screw Driver                              |
| 10       | 2552P    | Pilot Lamp                                      |
| 4        | 2896P    | Power Rheostat                                  |
| 3        | 2960P    | Lubricant - General Purpose                     |
| 3        | 2961P    | Lubricant - Motor                               |
| 2        | 2745P    | 4-Point Rotary Switch                           |
| 30       | 2999P    | Blotter Pad                                     |
| 1        | 6070P    | Technical Manual                                |

TM 11-441

[A. G. 062.11 (11-3-42)]

BY ORDER OF THE SECRETARY OF WAR:

G. C. MARSHALL,  
Chief of Staff.

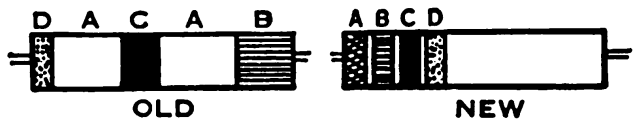
OFFICIAL:

J. A. ULIO,  
Major General,  
The Adjutant General.

DISTRIBUTION:

IBn, and H7, 17 (2); IBnl, 11, 18 (2); IC 6, 7, 11, 17, 18 (2).  
(For explanation of symbols see FM 21-6.)

TABLE 4—RMA STANDARD RESISTOR COLOR CODE



- A—Color for 1st significant figure.
- B—Color for 2nd significant figure.
- C—Color for No. of Ciphers or Multiplier.
- D—Gold or silver indicates tolerance, when applied.

| Color    | Significant Figure | Multiplying Value |
|----------|--------------------|-------------------|
| Black    | 0                  | 1                 |
| Brown    | 1                  | 10                |
| Red      | 2                  | 100               |
| Orange   | 3                  | 1,000             |
| Yellow   | 4                  | 10,000            |
| Green    | 5                  | 100,000           |
| Blue     | 6                  | 1,000,000         |
| Violet   | 7                  | 10,000,000        |
| Gray     | 8                  | 100,000,000       |
| White    | 9                  | 1,000,000,000     |
| Gold     | 5% Tolerance       | 0.1               |
| Silver   | 10% Tolerance      | 0.01              |
| No Color | 20% Tolerance      | —                 |

EXAMPLES

|              |           |           |                  |
|--------------|-----------|-----------|------------------|
| 500,000 ohms | Green (5) | Black (0) | Yellow (x10,000) |
| 25,000 ohms  | Red (2)   | Green (5) | Orange (x1000)   |
| 100 ohms     | Brown (1) | Black (0) | Brown (x10)      |

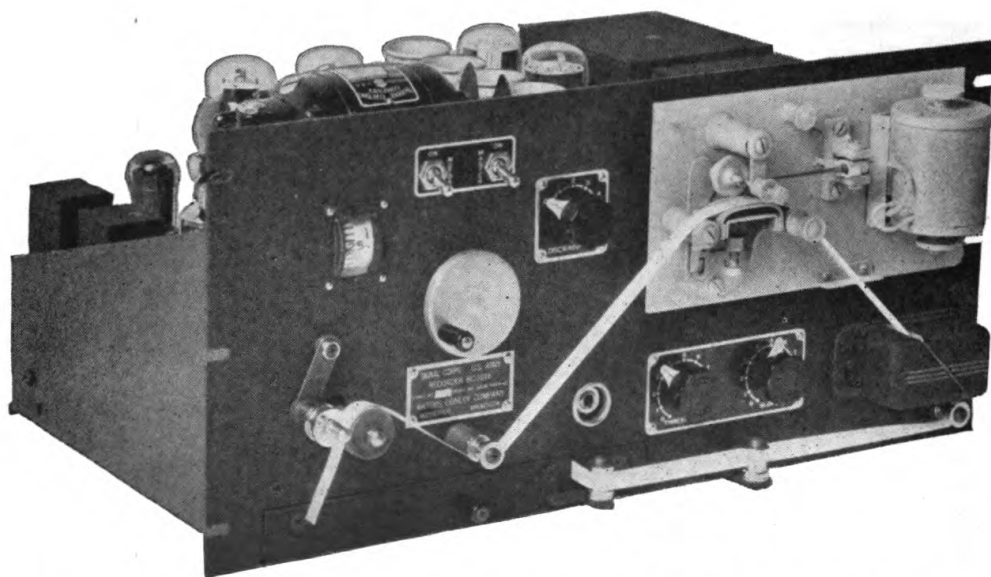


Figure 14—Recorder BC-1016, Front View—Removed from Cabinet.

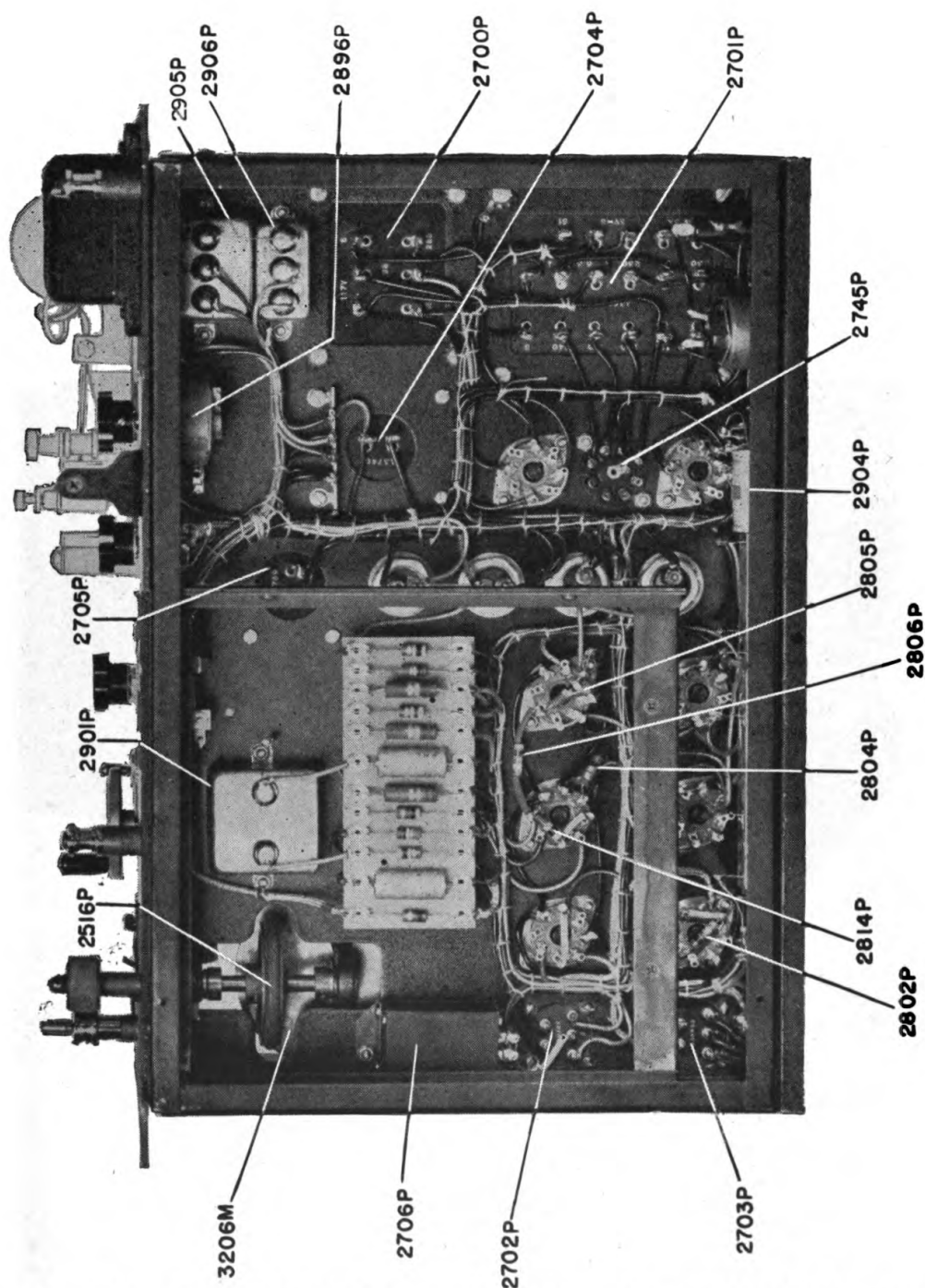


Figure 15—Recorder BC-1016, Chassis—Bottom View With Plate Removed

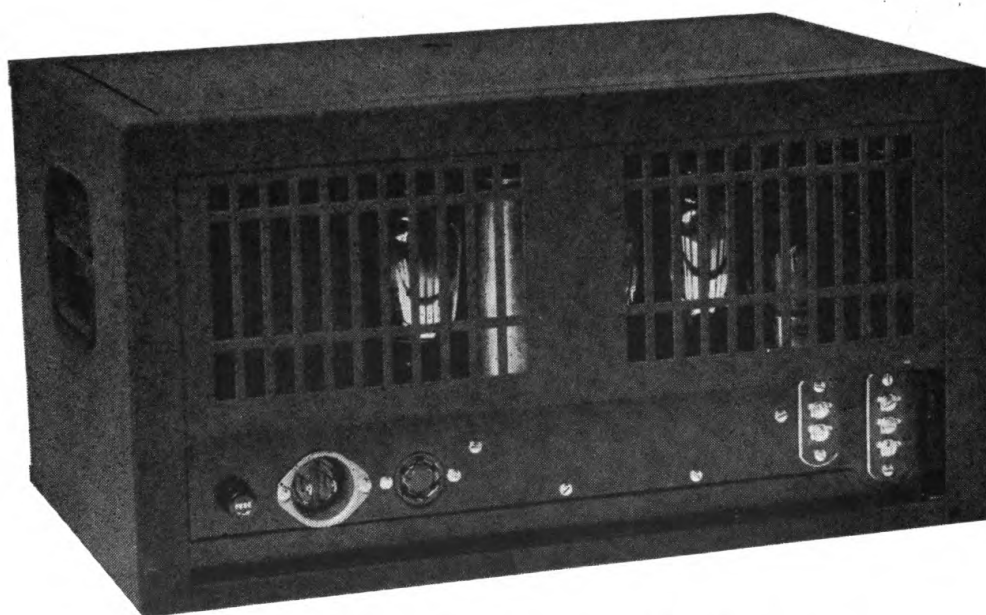


Figure 16—Recorder BC-1016, Rear View in Cabinet.



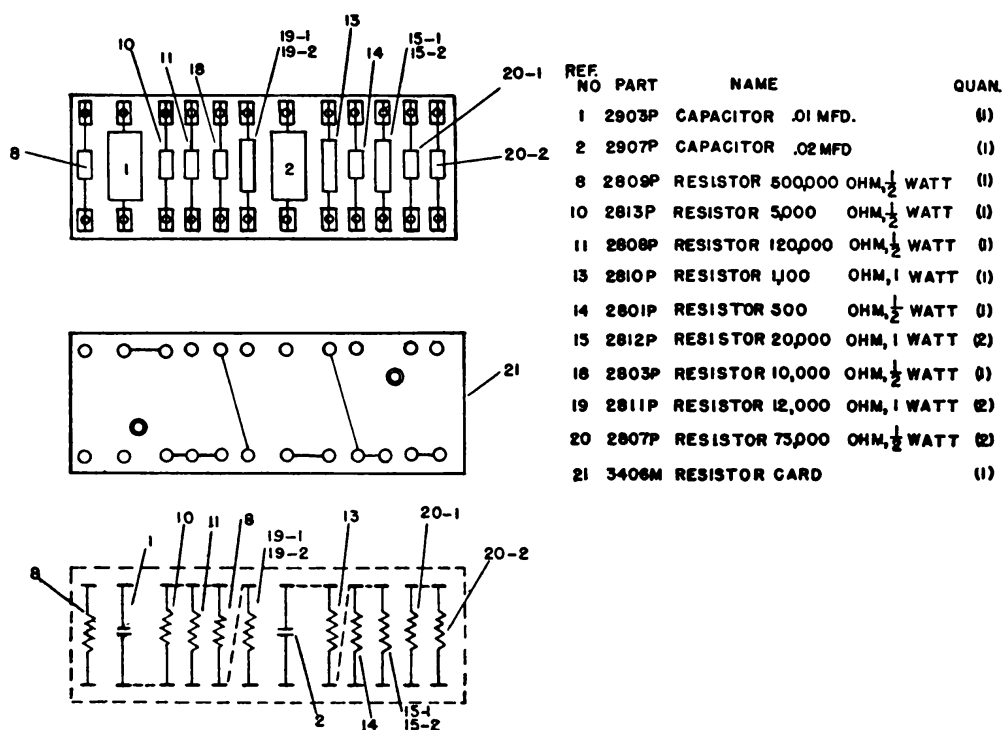


Figure 17—Recorder BC-1016—Resistor and Capacitor Mounting Card.

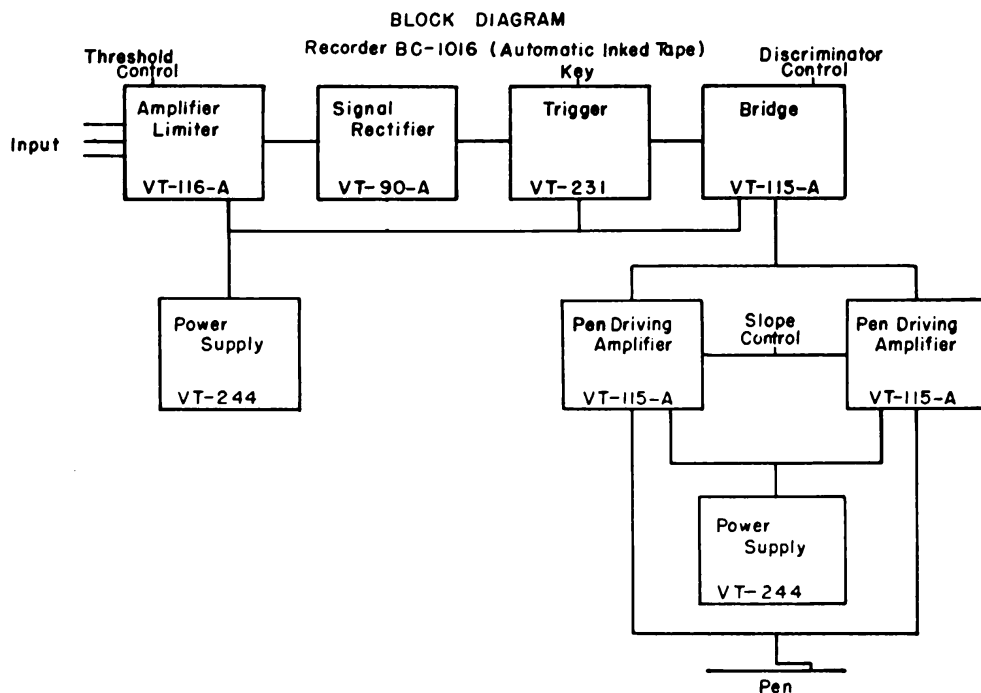


Figure 18—Recorder BC-1016, Simplified Block Diagram.

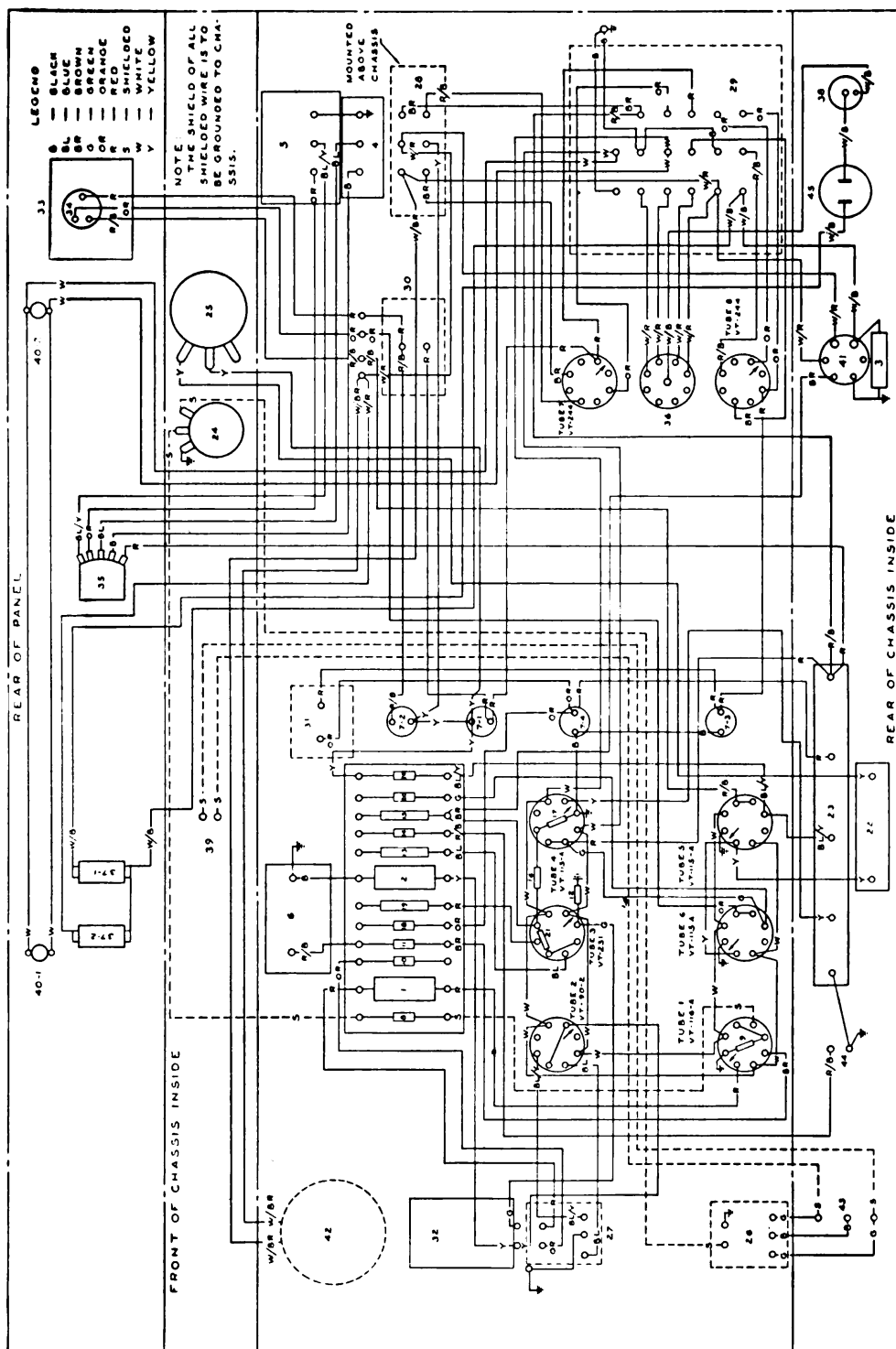


Figure 19—Recorder BC-1016, Wiring Diagram Showing Color Code.

## NOTICE

APPROVED SUBSTITUTE WIRE WAS USED AS SHOWN BELOW ON CONTRACT NO. 15559, SERIAL NOS. 1 to 200 INCL.

### Per Diagram

|                         |                                       |
|-------------------------|---------------------------------------|
| Orange.....             | Yellow—ends Dipped in Orange Paint    |
| Orange.....             | Yellow with Black Tracer              |
| Red—Black Tracer.....   | Red with ends Dipped in Black Paint   |
| White—Red Tracer.....   | Red with ends Dipped in White Paint   |
| White—Brown Tracer..... | Brown with ends Dipped in White Paint |
| White—Black Tracer..... | Black with ends Dipped in White Paint |
| Blue—Yellow Tracer..... | Yellow with ends Dipped in Blue Paint |

As shown Fig. 19 Page 40, also Fig. 7 Page 20.

